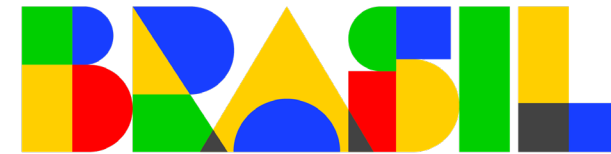


PANEL – PUBLIC POLICIES

THE BRAZILIAN EXPERIENCE WITH ETHANOL

**MINISTÉRIO DE
MINAS E ENERGIA**

GOVERNO FEDERAL



UNIÃO E RECONSTRUÇÃO

José Nilton de Souza Vieira

General-Coordinator of Ethanol and Biomethane

Summary

Public policies for ethanol

Use of ethanol in high concentrations in Brazil

Environmental and Economic benefits of using ethanol

Regulatory instruments

Conclusions

Some Public Policies for Ethanol in Brazil

Mandatory mixing mandate (27%) in all gasoline sold

Tax differentiation (Federal and in several States)

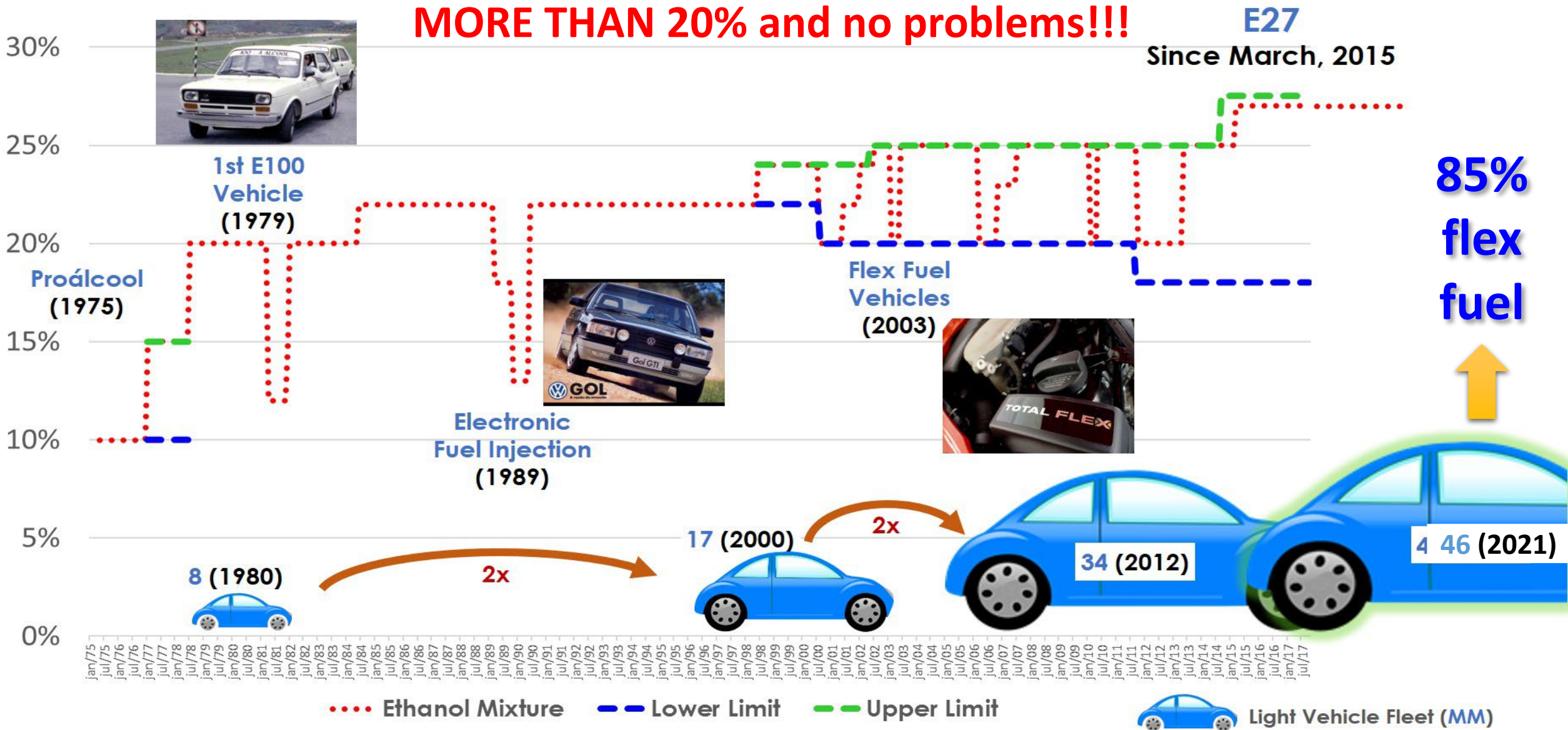
Free prices in the fuel market

Contracts and minimum stocks between season crops

RenovaBio

Blending ethanol into gasoline in Brazil

40 YEARS EXPERIENCING MIXTURES
MORE THAN 20% and no problems!!!



85% flex fuel



..... Ethanol Mixture - - - Lower Limit - - - Upper Limit

Light Vehicle Fleet (MM)

FLEX-FUEL VEHICLES



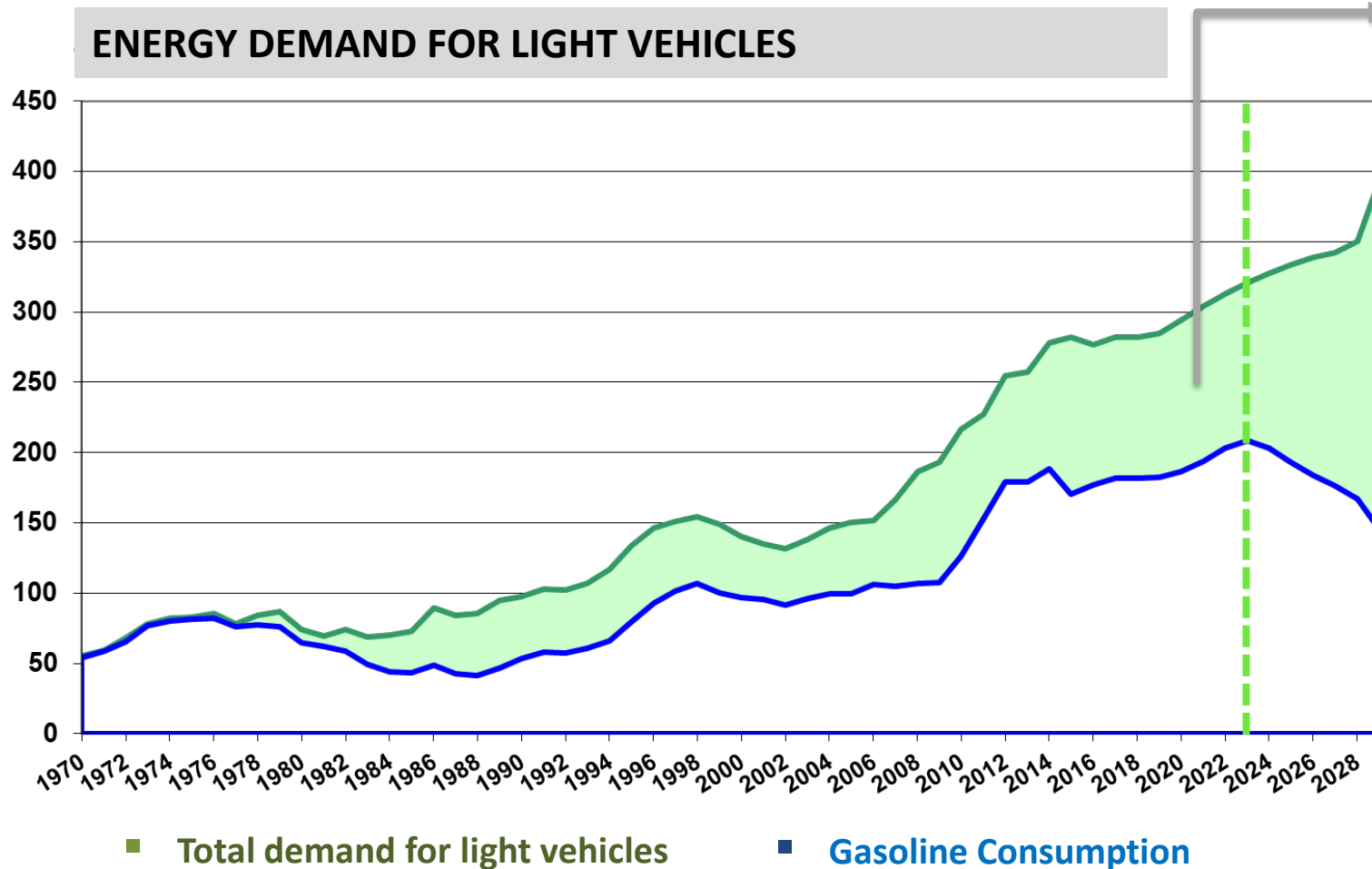
These vehicles offer Brazilian consumers a privileged option: the possibility of choosing the desired fuel for each delivery, depending on the relative price of the products and their preferences..

The possibility of choice guarantees:

- greater competition and
- based on market mechanisms, reduces fuel price risk for flexible vehicle owners

This condition offers structural protection to the consumer against variations in the value of gasoline..

SAVINGS WITH ETHANOL AND CO2 AVOIDED



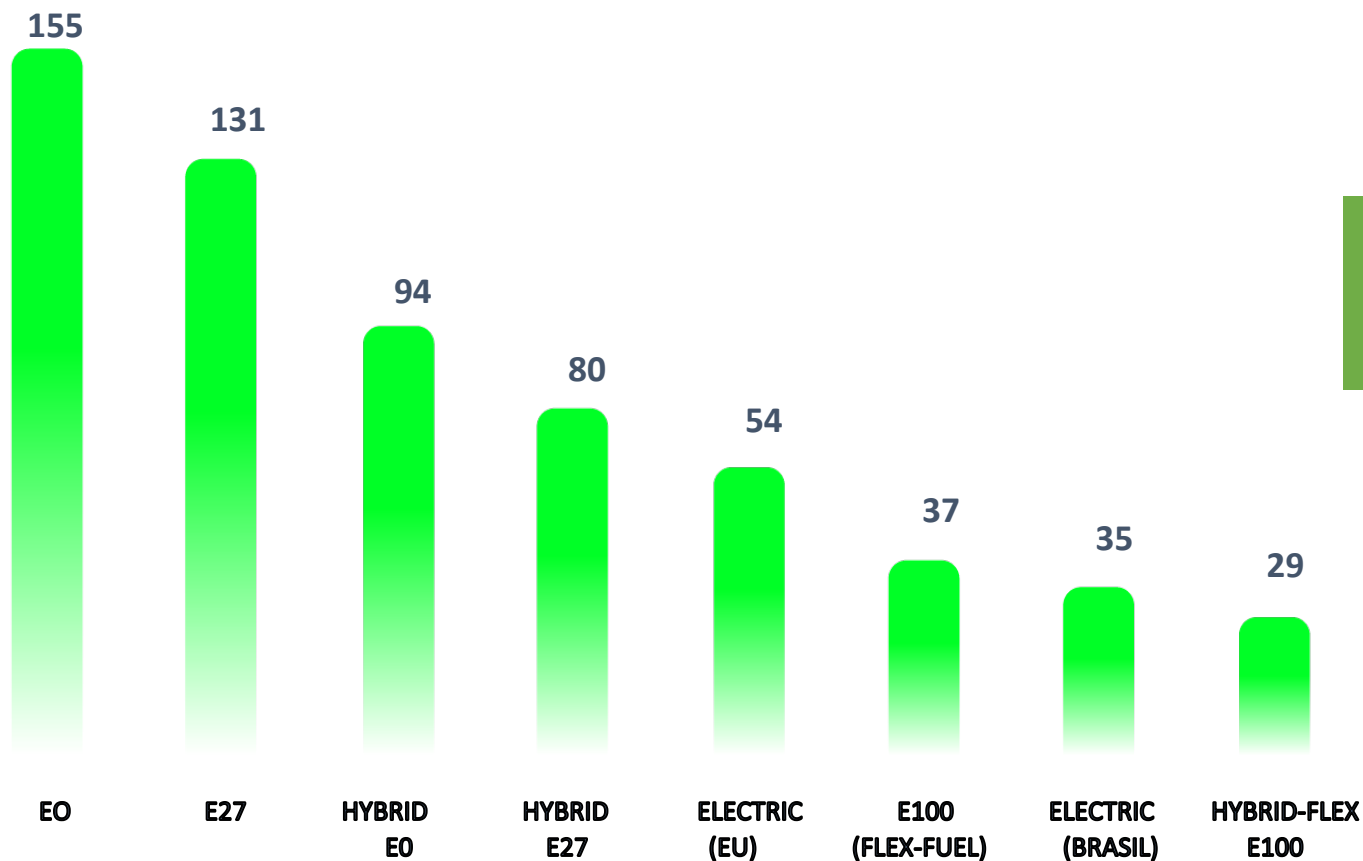
3.58 billion BEP saved
equivalent to 4 years of current oil production in the country.

2.1 billion tons of CO₂eq avoided emissions

700 millions



Emissions comparison (gCO₂/km)



It does not consider emissions from vehicle manufacturing.



GASOLINE WITH ETHANOL

ANHYDROUS ETHANOL
(PRODUCERS)

GASOLINE A (REFINERIES)

DISTRIBUTOR BASE

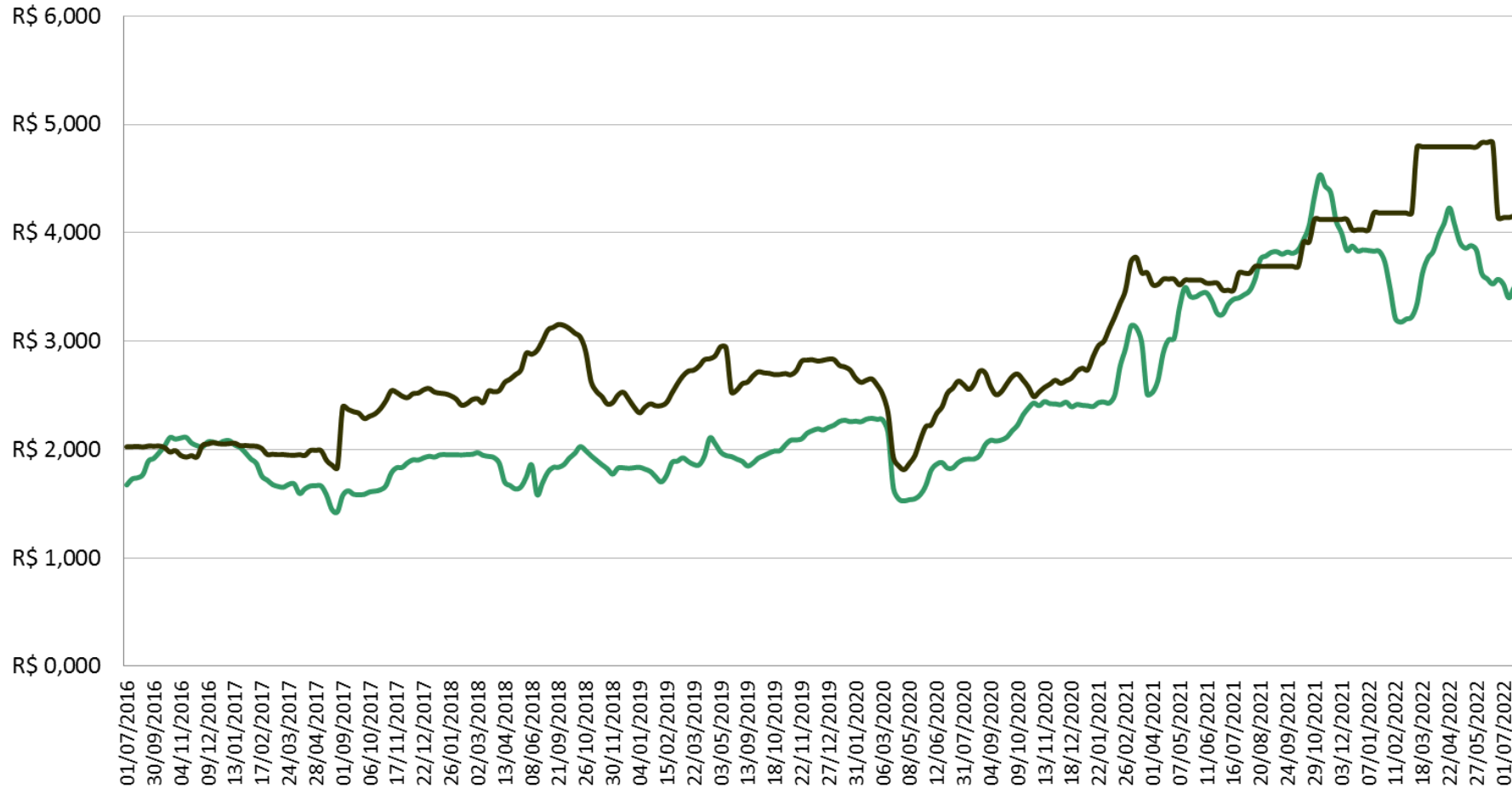
EACH 10 PERCENTAGE
POINTS OF ETHANOL
MIXTURE...

REFINERY
GASOLINE COSTS
6% LESS!

- OCTANE OF THE GASOLINE A PRODUCED BY THE REFINERY DEPENDS ON THE MIXTURE PERCENTAGE
- THE HIGHER THE % ANHYDROUS, THE LOWER THE NECESSARY OCTANE OF THE GASOLINE PROVIDED BY THE REFINERY
- THE HIGHER OCTANE, THE MORE EXPENSIVE THE GASOLINE IS

COST OF ACQUISITION OF DISTRIBUTORS

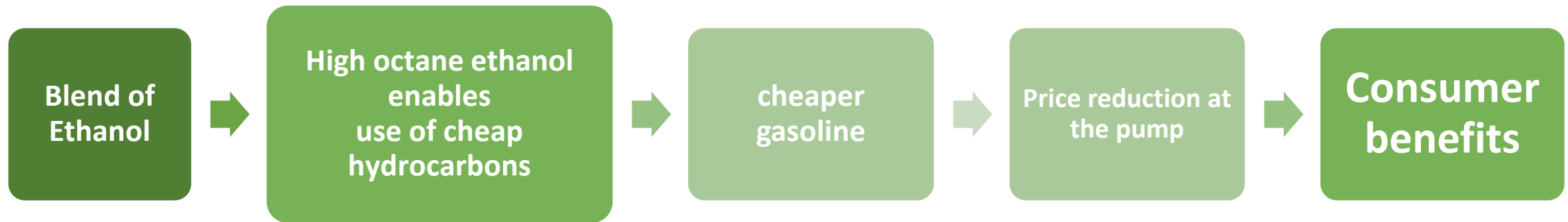
Gasoline and Anhydrous (Brazil) R\$/liter * With federal taxes



**Ethanol is,
on average,
17% cheaper
than
gasoline**

— Anhydrous — Gasoline A

BENEFITS FOR THE CONSUMER



Economic and
Environmental
benefits

- 9% discount on chains used for gasoline +
- 17% discount on the price of anhydrous ethanol compared to gasoline =
- 10% CHEAPER GASOLINE AT THE SERVICE STATION FOR THE CONSUMER (E15)

- **GASOLINE 15% CHEAPER AT THE SERVICE STATION FOR THE CONSUMER (E25)**

Current Regulatory Instruments

Sales regime for one-year supply contracts, based on the previous year's market

Mandatory minimum stocks for the period between harvests (for producers and distributors)

Direct sale of ethanol by producer to service stations (E100)

Market information system that must be provided by agents (sales, stocks)

What can we conclude?

The mandatory mixture of ethanol in gasoline is the best option for everyone, especially for the consumer

Brazil has very important technical references to validate the use of ethanol in high levels

We have to value the vocation of our regions for the production of bioenergy

There are regulatory instruments capable of guaranteeing supply and demand

Cảm ơn rất nhiều!
Thank you very much!
MUITO OBRIGADO!

E-mail: bio@mme.gov.br

Public Policies

Ethanol Blending Mandate

Environmental benefits

Economic benefits

Regulatory Instruments

Conclusions

INCREASE IN MIXING PERCENTAGE

1. September/2014:

The law is passed that increased the mixing percentage from 25% to 27.5% “*El The Executive Branch may raise the aforementioned percentage to the limit of 27.5% (twenty-seven integers and five tenths percent), as long as its technical viability is confirmed. (...)*”

2. MME request to Petrobras for evaluation of technical feasibility of E27.5 :

- CENPES responsible for carrying out the tests
- **Created GT coordinated by the MME with the participation of different segments (ME – MAPA – ANFAVEA – ABRACICLO – ABEIFA – UNICA – INMETRO – PETROBRAS)**
- Test execution lasted 13 weeks

TEST PLAN

TYPES OF TEST		TESTED FUELS
VEHICLES AND MOTORCYCLES	Emissions	E22 (Standard), E25, E27.5 y E30
	Consumption (Autonomy)	
	Performance	E25, E27.5 Y E30
	Manageability	
MOTORS (Bench)	Torque and power curves	E22 (Standard), E25, E27.5 y E30
FUELS	Specific mass	E22 (Standard), E25, E27.5 y E31
	Density	
	Distillation	
	Flash point	
	Lubricity	
	Oxidation stability	

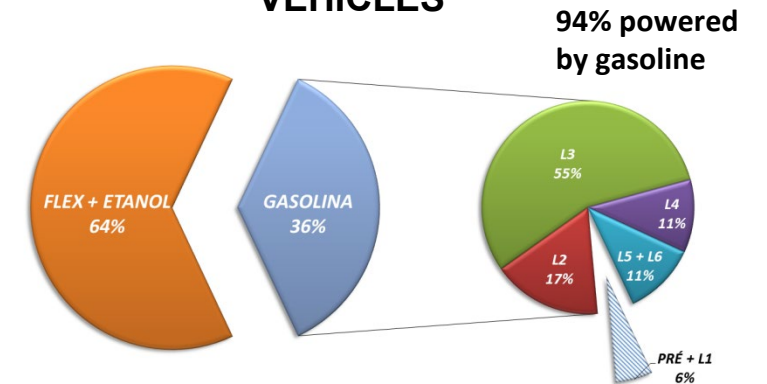
VEHICLES and MOTORCYCLES

VEHICLES

Vehicle Code	Phase	Year/Model	Km	Cylinder capacity	Transmission	Catalyst	Fuel Supply System
L2A	L2	1995/1996	251030	1.0	manual	yes	electronic carburetor
L2B	L2	1995	141867	1.6	manual	yes	single point injection
L3A	L3	2001	155392	1.8	automatic	yes	multipoint injection
L3B	L3	1999/2000	229332	1.0	manual	yes	multipoint injection
L4A	L4	2008	98349	2.0	automatic	yes	multipoint injection
L5A	L5	2009/2010	72471	1.6	manual	yes	multipoint injection
L5B	L5	2010	40547	2.0	automatic	yes	multipoint injection
L6A	L6	2013/2014	6035	1.6	automatic	yes	turbo direct injection
L6B	L6	2013/2014	5333	1.6	automatic	yes	turbo direct injection
PM1 A	PM1	2002	91719	125	no		carburetor
M1 A	M1	2005	59374	150	no		carburetor
M2 A	M2	2008	50307	125	no		carburetor
M3 A	M3	2009	124	125	yes		electronic injection
M3 B	M3	2010	105	300	yes		electronic injection

MOTORCYCLES

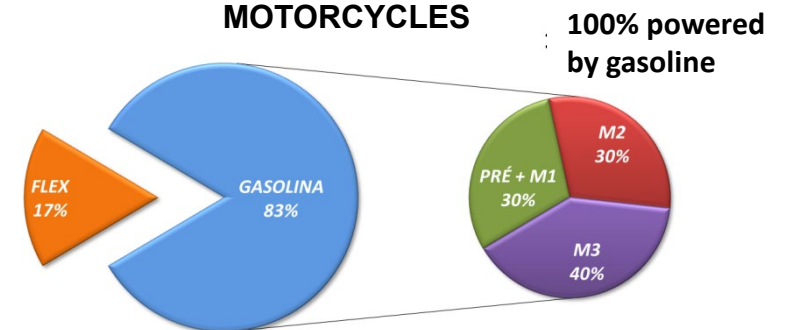
VEHICLES

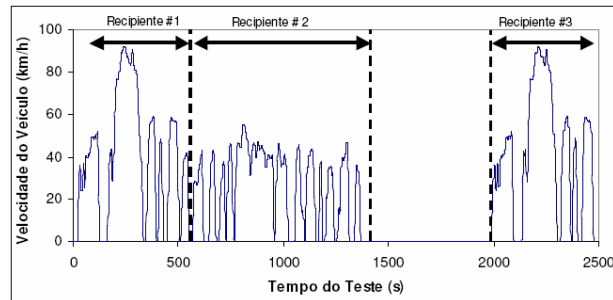


→ Emissions only

→ Other tests

MOTORCYCLES





EMISSIONS (NBR 6601 / NBR 12026)

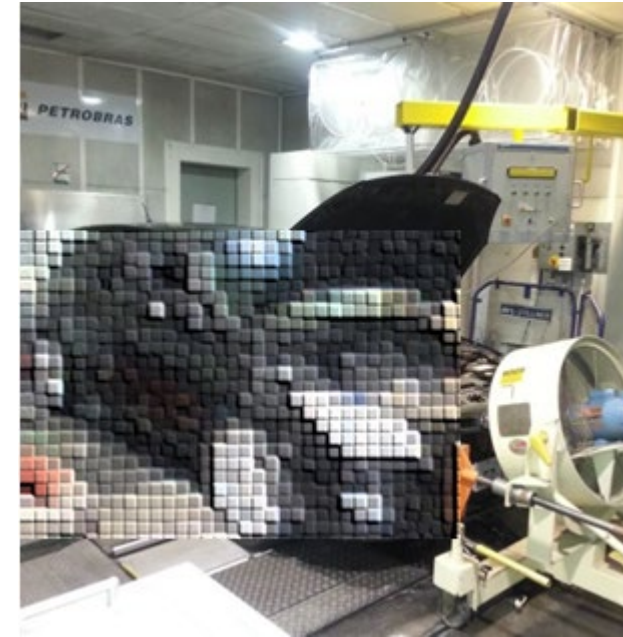
AUTONOMY (NBR 7024)

CO, THC, NMHC, NO_x, CO₂ e

Aldehydes

Urban and Highway Autonomy

- ✓ Tests carried out at LACTEC and CENPES
- ✓ E25 , E27,5 and E30 in relation to E22
- ✓ E27,5 and E30 in relation to E25
- ✓ At least 3 tests / fuel
- ✓ Statistical treatment



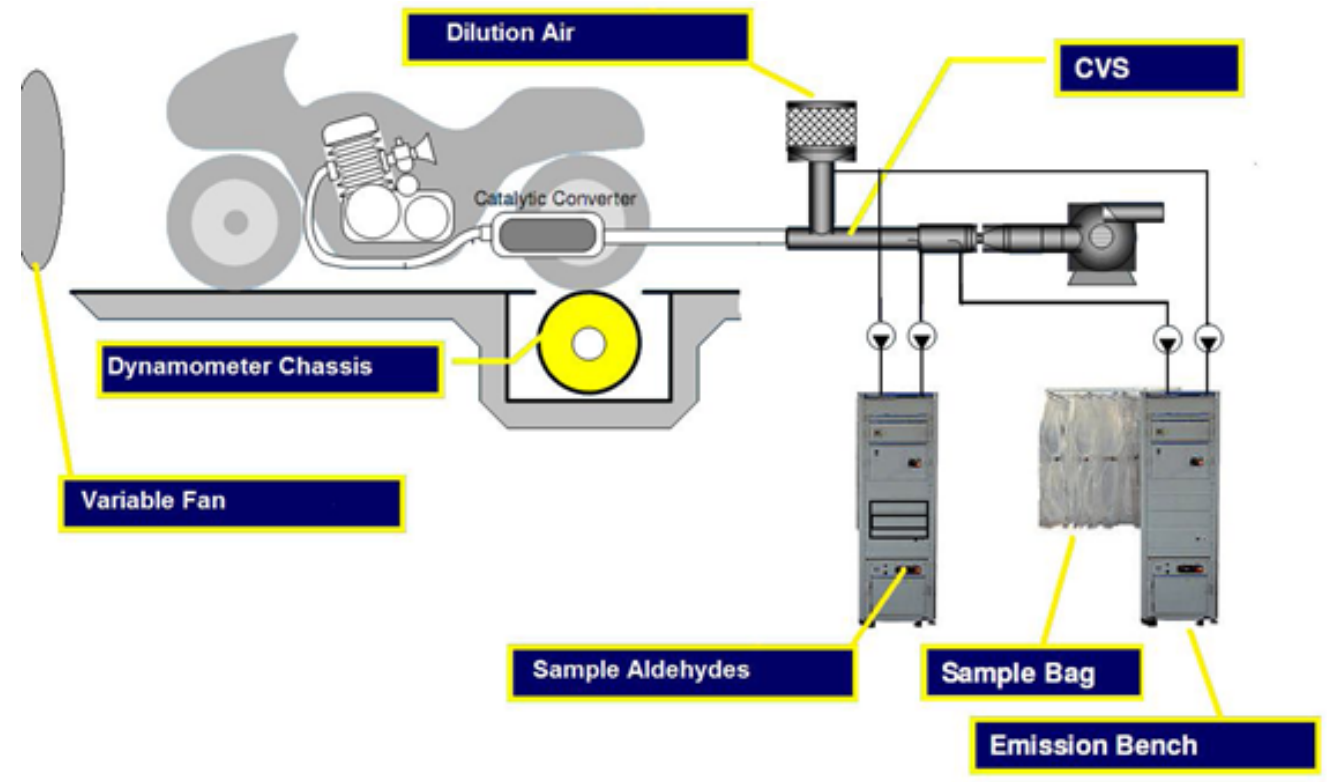
MOTORCYCLES



CONAMA Resolution No. 297/2002 European Directive n° 97/24/EC

CO, THC, NO_x y CO₂

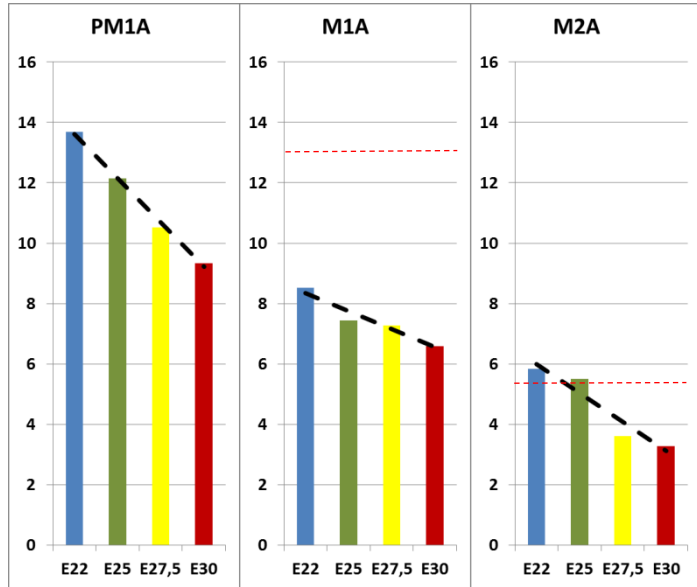
Autonomy



- ✓ Tests carried out at LACTEC
- ✓ E25, E27.5 and E30 in relation to E22
- ✓ E27.5 and E30 in relation to E25
- ✓ 3 tests / fuel
- ✓ Statistical treatment

TESTS AND RESULTS

PROMOT limits for 18,000 km (g/km):
M1=13.0, M2=5.5, M3=2.0.

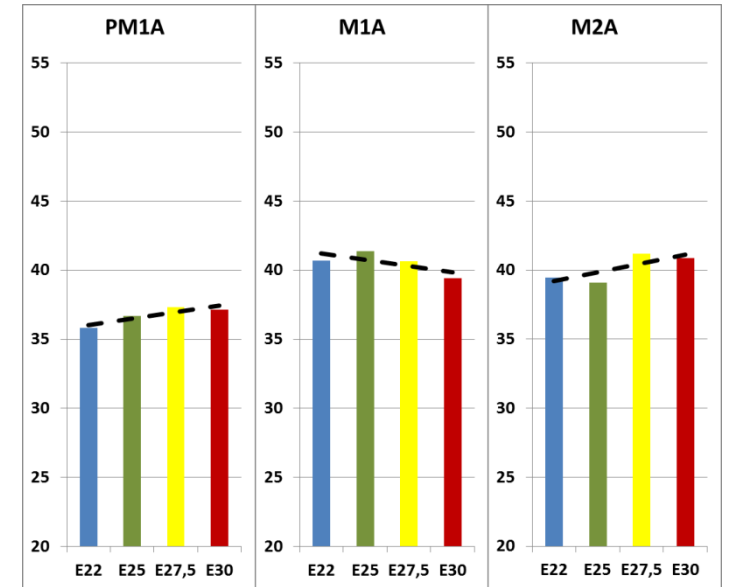


EMISSIONS

Comparison	PM1A	M1A	M2A	M3A	M3B
E27,5 x E25	-12%	-7%	-18%	s/dif.	-7%

✓ CO reduction trend in all motorcycles.

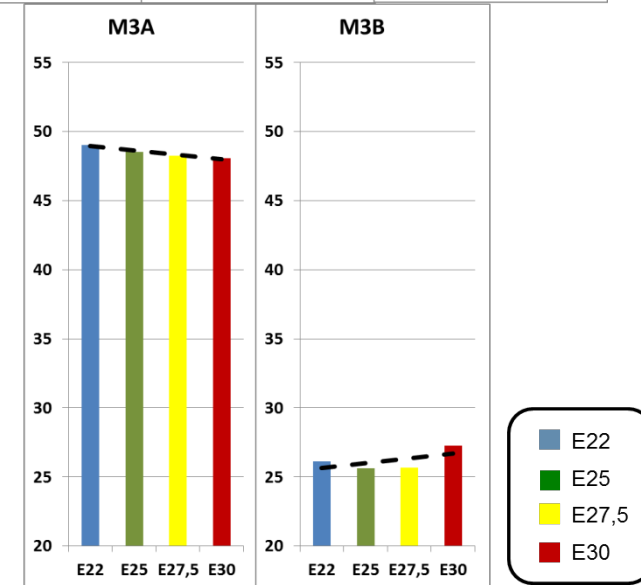
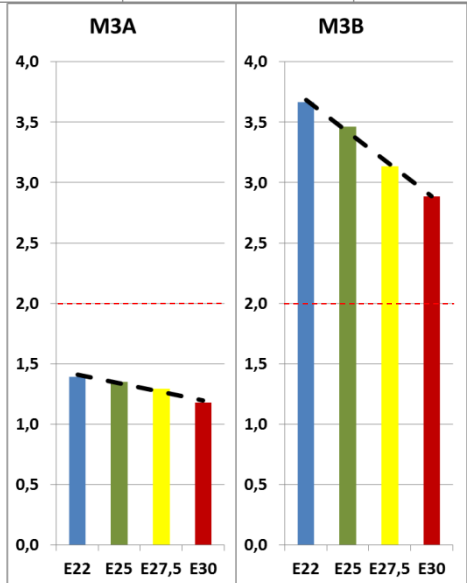
Autonomy (Km/Liter)



AUTONOMY

Comparison	PM1A	M1A	M2A	M3A	M3B
E27,5 x E25	s/dif.	s/dif.	s/dif.	-1%	s/dif.

✓ Indefinite trend



Legend:
E22 (Blue)
E25 (Green)
E27,5 (Yellow)
E30 (Red)

Legend:
E22 (Blue)
E25 (Green)
E27,5 (Yellow)
E30 (Red)

TESTS



SPEED RECOVERY

- ✓ Methodology adapted from the SAE J1491 standard;
- ✓ Measurement of the time spent during speed restarts between 40 and 80 km/h, 60 and 100 km/h and 80 and 120 km/h;
- ✓ Vehicles with manual transmission tested with the second to last, penultimate and last gear engaged;
- ✓ Vehicles with automatic transmission tested in position "D" (drive);
- ✓ Tests carried out in the North and South directions
- ✓ Statistical treatment



IGNITION AND COLD DRIVING

- ✓ CENPES Procedure
- ✓ refrigerated container
- ✓ Start: Engine oil = 0°C
- ✓ Conditioning: 10 km run
- ✓ Rotation profile registration
- ✓ Qualitative evaluation of the failures that occurred

VEHICLES EVALUATED BY ANFAVEA



Anfavea – Tests in MY 2013, 2014 and 2015.

NEW VEHICLES
(2014)



Hybrids



COMPARISON OF ENERGY EFFICIENCY AND ECONOMIC VIABILITY (E30 X E15)

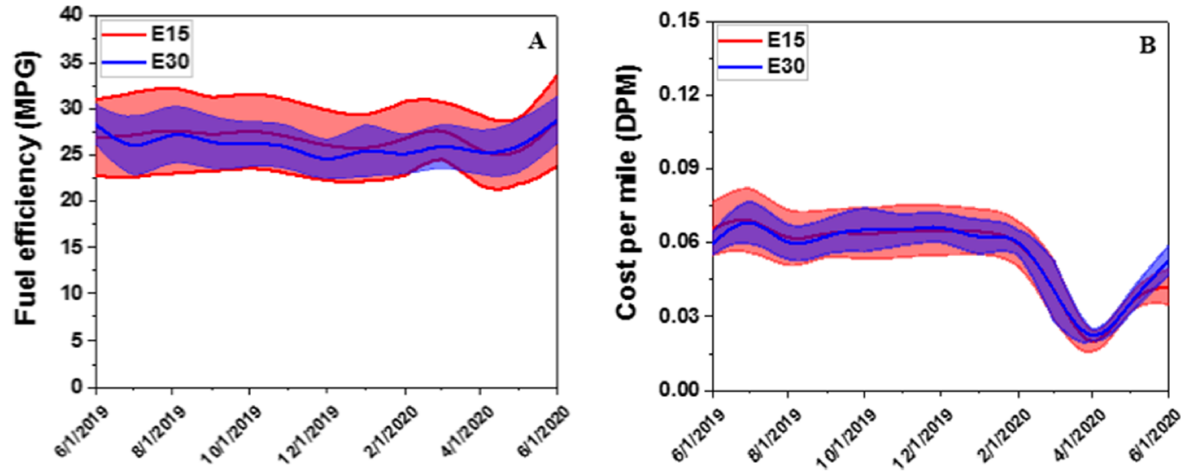
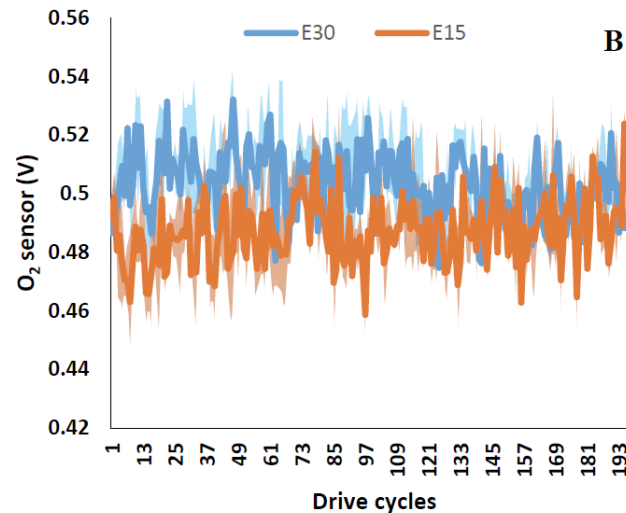


Fig. 4. Comparison of the economic feasibility of using E15 and E30. (A) Time-course fuel efficiency of the two different ethanol concentrations. (B) Time-course price per mile for the two different ethanol concentrations.

EVALUATION OF THE ADAPTABILITY OF THE E15 GASOLINE ENGINE USING E30



OTHER STUDIES



Fuel 306 (2021) 121629



Contents lists available at ScienceDirect

Fuel

journal homepage: www.elsevier.com/locate/fuel



Full Length Article

Investigating the effect of E30 fuel on long term vehicle performance, adaptability and economic feasibility

Adil Alsiyabi, Seth Stroh, Rajib Saha*

Department of Chemical and Biomolecular Engineering, University of Nebraska-Lincoln, USA



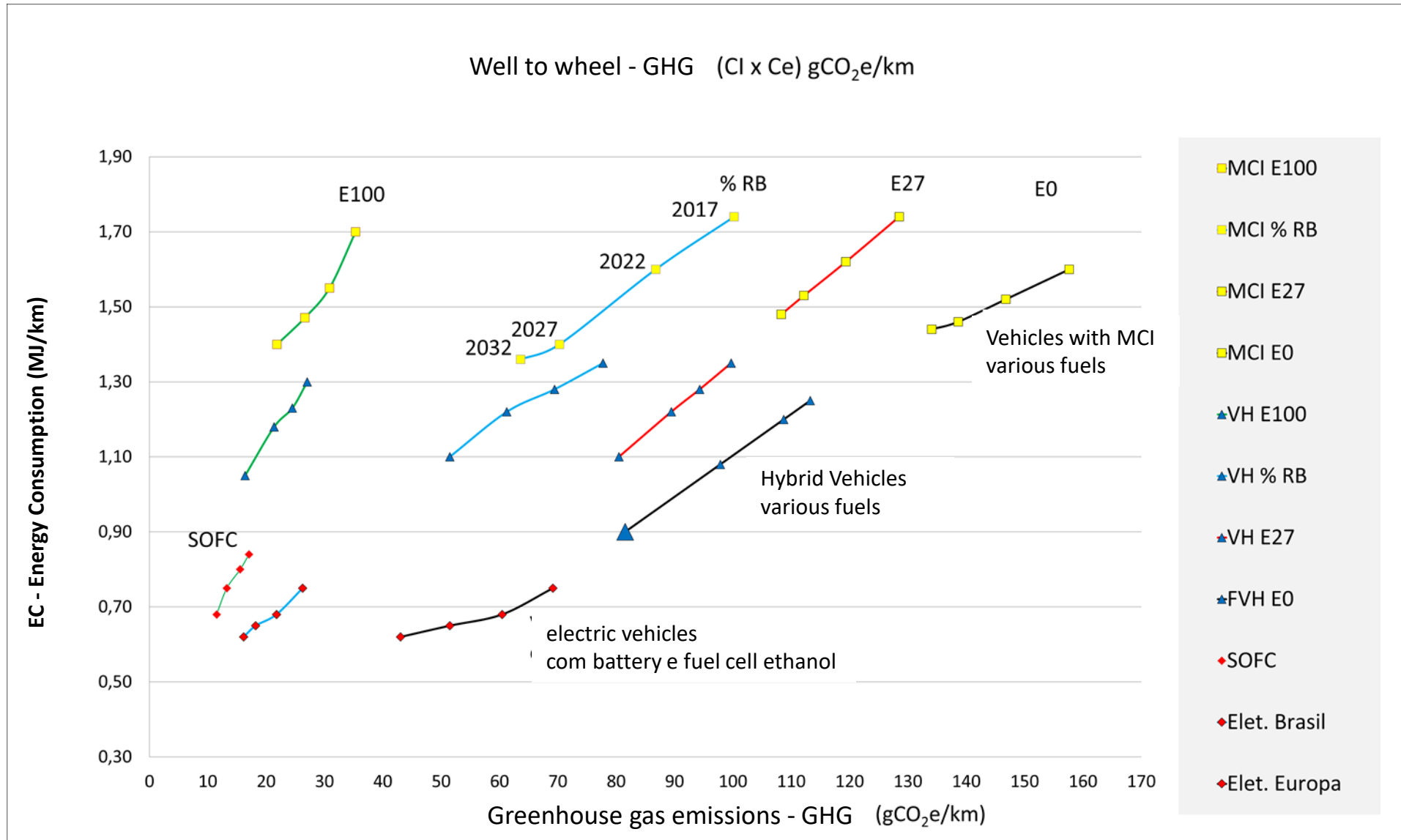
Conclusions:

It was observed that **the engine control module of non-flexible vehicles was capable of maintaining the operation of the main parameters** (i.e., optimal air-fuel ratio and engine temperature) at their desired set points.

Additionally, **machine learning models trained to predict instantaneous volumetric efficiency** (as a performance metric) showed no difference between the two fuel types.

Finally, **the use of E30 fuel was found to become economically viable when price differences exceed 2.5%** (i.e. when E30 is 2.5% cheaper).

INTEGRATION OF PUBLIC POLICIES FOR SUSTAINABLE MOBILITY



REDUCTION OF CO2 EMISSIONS IN BRAZIL COMPARED TO EUROPE

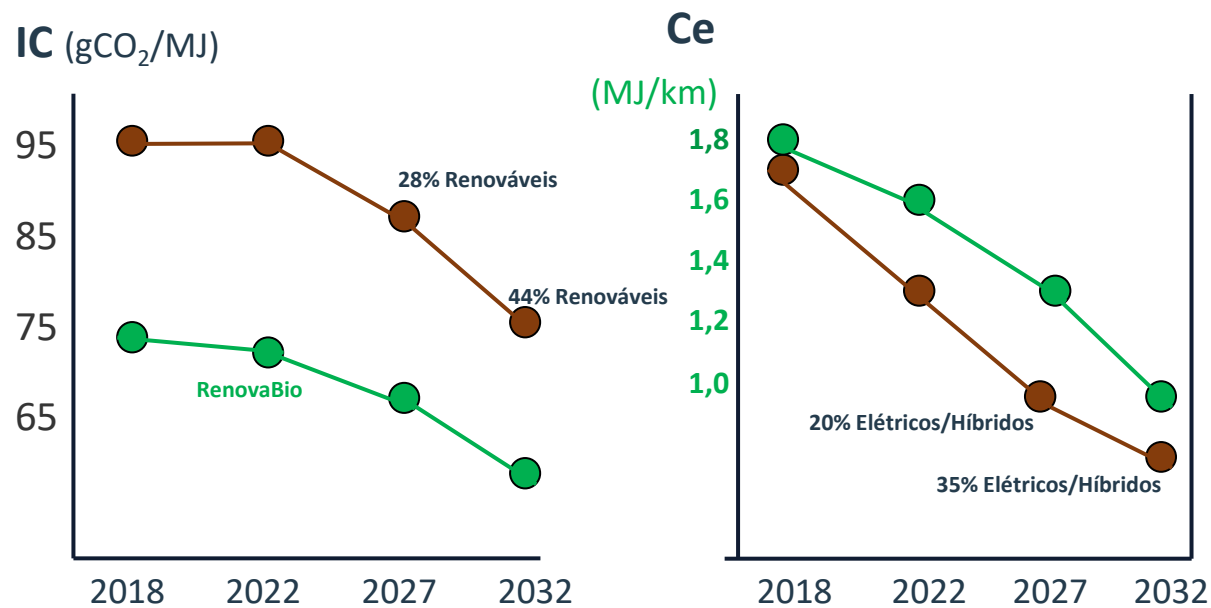
$$T_{GEE} = IC \text{ (gCO}_2\text{/MJ)} \cdot Ce \text{ (MJ/km)} = \text{gCO}_2\text{/km}$$

well-to-wheel

● EUROPE
● BRASIL

Premise:

- Average fleet profile (BR and EUROPE) with:
1. Characteristics of energy sources;
 2. Expected average efficiency;
 3. Penetration of electrified vehicles (EUROPA);
 4. Compliance with current/proposed policies.



Bottom line for the environment (well-to-wheel)



ANHYDROUS ETHANOL: Marketing regimes (RANP 67/2011)

Supply contract regime - mode of acquisition of anhydrous ethanol fuel in order to qualify for the purchase of gasoline A, **subject to prior approval by the ANP**, of the contracting of anhydrous ethanol fuel between an ethanol supplier anhydrous and distributor of automotive liquid fuels, in the period between June 1 of each year and May 31 of the following year.

Direct purchase regime - modality of acquisition of anhydrous ethanol fuel in order to qualify for the purchase of gasoline A, **with prior approval by the ANP**, of the acquisition of anhydrous ethanol fuel for the formation of its own final stock each month , in sufficient volume for the sale of type C gasoline in the following month.

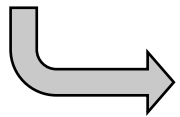
Two anhydrous purchasing schemes (by distributors) whose volumes are complemented by the spot market

Spot market transactions - mode of acquisition of anhydrous ethanol fuel for qualification purposes for the acquisition of gasoline A, without prior approval from the ANP, for the acquisition of additional volumes to those provided for in the supply contract regimes and direct purchase.

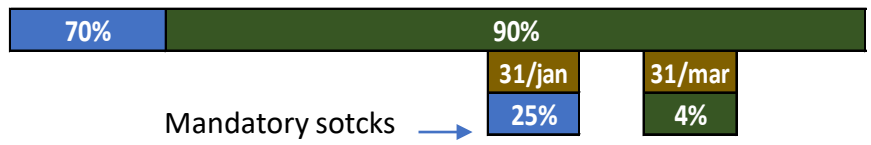
ANHYDROUS ETHANOL: Ethanol contracts and stocks (RANP 67/2011)

Year y-1												Year y												Year y+											
jan	fev	mar	abr	mai	jun	jul	ago	set	out	nov	dez	jan	fev	mar	abr	mai	jun	jul	ago	set	out	nov	dez	jan	fev	mar	abr	mai	jun	jul	ago	set	out	nov	dez
Período de Apuração do Mercado de Gasolina e Anidro												Período de Vigência dos Contratos (Art. 3 e 10 da RANP 67/2011)																							

02/mai
01/jul



Mandatory minimum percentages in the contract regime



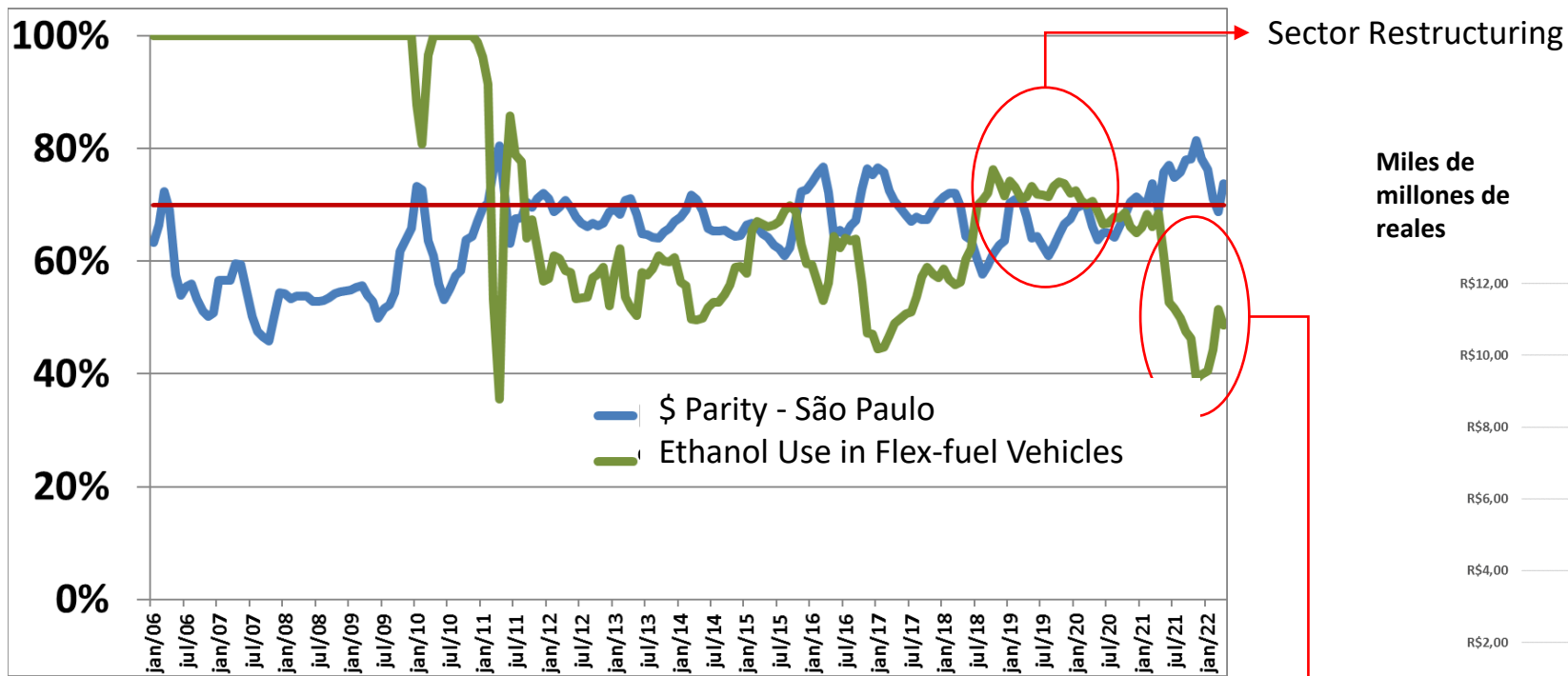
Mandatory stocks

31/jan
31/mar

Mandatory stock for those who have not reached 90% of the contract. That is, who is outside the Contracting Regime.

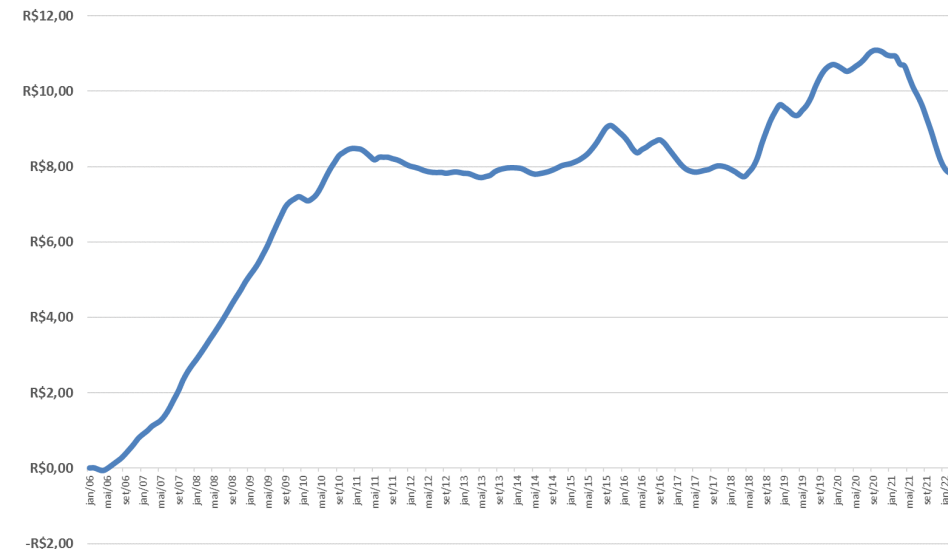
Mandatory stock for EVERYONE.

FLEX-FUEL VEHICLES BENEFITS FOR THE CONSUMER (EXAMPLE OF THE STATE OF SÃO PAULO)



Miles de millones de reales

Cumulative gain for consumers in the state of SP with the use of ethanol (E100) since 2006



Parity \$: Relationship between the price of ethanol (E100) and the price of gasoline (E27)



% use of E100 in flex-fuel vehicles



Accumulated profit for consumers in SP reached R\$ 8 billion